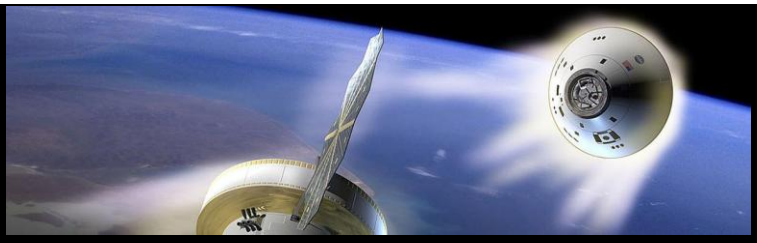
ORION

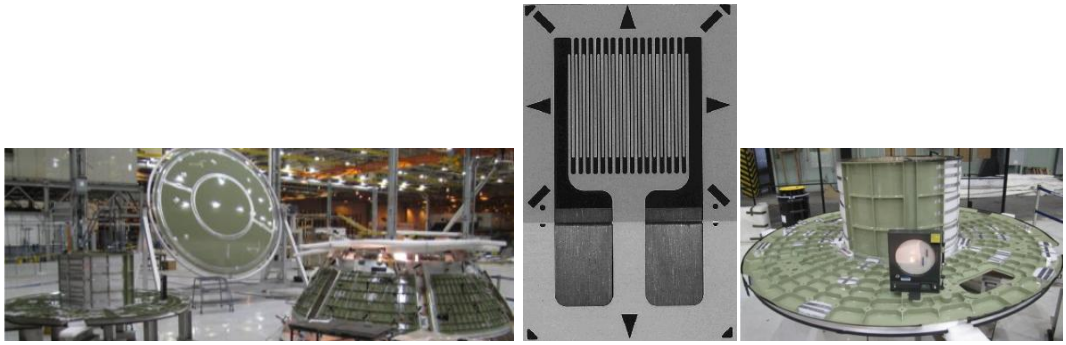
CREW EXPLORATION VEHICLE

PROJECT MILESTONES



January 2010

- **Progress continued over the holidays at the Michoud Assembly Facility in New Orleans, Louisiana as the team began installing strain gauges on the cone, upper tunnel and heat shield Ground Test Articles (Shown below left.)** Hundreds of small gauges (below middle) will be placed in various areas and positions on the Ground Test Articles (GTA) to measure the overall strain on the GTA when testing begins later this year in Denver, CO. The gauges are temporarily protected and held in place by pieces of foam that are custom fit for each socket on the GTAs. The Upper Tunnel (shown below right) has already been fitted with several gauges and foam with more gauge installations expected over the next week. Once the gauge installation is complete, the GTA sections will move into position to be welded together, which should occur later in the month.



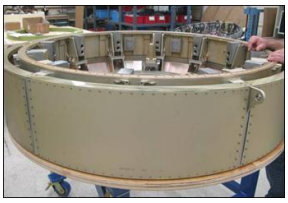
- **Data analysis has begun from last month's Attitude Control Motor (ACM) DM-1 testing (Shown below.)** The Pressure, Thrust Magnitude and Thrust Direction all appear to meet the requirements. There were some differences between the Thermal Model and the TC Data noted, but overall the Thermal Model was bounded and the trends matched. Accel data is still being analyzed and is expected on or before the 60-day test report.

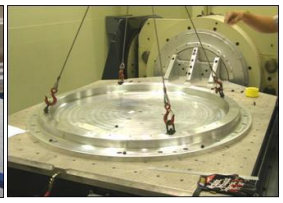
- **Work continued at the White Sands Missile Range (WSMR) in preparation for Pad Abort-1 with the sealing of the nozzle to the shroud interface gap on the jettison motor (shown below left.)** In addition, the Forward Bay Cover (FBC) Parachutes and gas generators were installed into the FBC (Shown below right.)

- **Installation of the Forward Bay Cover (FBC) started at the White Sands Missile Range on the Pad Abort-1 Crew Module (both pictures below.)** The cover is temporarily secured and is ready for a final harness mate, which will occur after the Launch Abort System (LAS) to Crew Module(CM) testing is complete. A Boroscope camera was used to survey the hidden areas underneath the cover and external measurements have been taken to verify appropriate and consistent clearances to the FBC.


- **Progress continues at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana on the installation of the strain gauges (shown below left) on the Orion Ground Test Article (GTA.)** Installation was completed on the GTA Cone, Aft Bulkhead and Forward Bulkhead. Shown below right are members of the Michoud team with the GTA Aft Bulkhead (comprised of two gore panels and a center panel) that forms the bottom of the crew module.


- **The Low Impact Docking System (LIDS) Ground Test Article (GTA) Mass Simulator deliverable (shown in pictures below) is completely assembled (on schedule) and is headed for vibration testing at Johnson Space Center (JSC) for model correlation in the upcoming weeks.** The vibration test plate (shown below far right) has been fit-checked with the test facility and the overall LIDS GTA is still on schedule for delivery to Denver, Colorado in March.





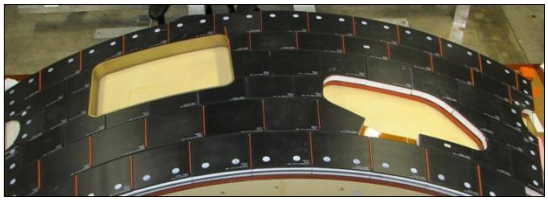
- **Shown below is the completion of the wet fastening of all six sections of the Heatshield backbone stiffener assembly of the Orion Crew Module ground test article at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** The completed assembly was relocated to the main assembly area where strain gauge installation will begin.

- **Progress continued on the Ground Test Article Thermal Protection System (TPS) Composite Heatshield.** Shown below is the installation of the heatshield core and completion of the core splice.

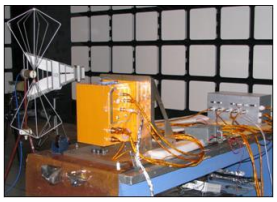
- **Installation of the working display units in the low fidelity mockup at Johnson Space Center has been completed (shown below.)** The display units are capable of showing six different displays including a Primary Flight Display, Environmental Control and Life Support Display and an eProcedure Display.

- **Shown below is the Launch Abort System (LAS) Safe and Arm System being installed (in the LAS canopy structure) at White Sands Missile Range in support of the upcoming Pad Abort 1 ground test.** The Safe and Arm System is similar to what is currently used in the Space Shuttle and serves as a final "check off" preventing the motors from being accidently ignited.

- **United Space Alliance at Kennedy Space Center has completed the tile pre-fit installation on Panel E (shown below).** This panel is part of the Thermal Protection System (TPS) that will be used on the Ground Test Article (GTA) to better understand how Orion environments affect tiles. New CAD modeling methods and tight tolerance composite panels have improved tile installation methods over prior space shuttle processes.



- **The Sensor Test for Orion Relative Navigation Risk Mitigation (STORRM) team began risk reduction testing of the navigation unit at Ball Aerospace & Technology Company.** The Sensor Enclosure Assembly (SEA) and Avionics Enclosure Assembly (AEA) were electrically integrated and powered on (shown below left.) The picture below right shows the Class 3 docking target augmented with the reflective elements (minus the standoff cross with reflective element) (left) and the chart used for docking camera images (right) used during Electromagnetic Interference (EMI) testing.




- **The Low Impact Docking System (LIDS) Ground Test Article (GTA) has been mounted on the vibration test fixture (shown below) for acceptance random vibration and sinusoidal vibration testing.** Accelerometers have been mounted on the test article and are currently being interfaced with the data collection system. Random vibration testing has begun with sinusoidal testing to follow.

- **Ongoing renovations continue at the Space Power Facility in Sandusky, Ohio. A special mixture of self-consolidating concrete was poured to a height of 15.5 feet in the Reverberant Acoustic Test Facility (RATF).** This first vertical wall segment begins creation of the 'horn room,' (shown below) a room containing 36 nitrogen-driven acoustic modulators with horns to create overall sound pressure levels of 163 dBA (decibels adjusted) in the adjacent 101,500 cubic foot reverberant chamber. The RATF is one of two new test facilities under construction. The other is the Mechanical Vibration Facility (MVF), a three–axis servo-hydraulic shaker table. The two facilities will test the Orion Crew Exploration Vehicle and other spacecraft with simulated vibro-acoustic loads that are experienced during launch and supersonic ascent conditions.

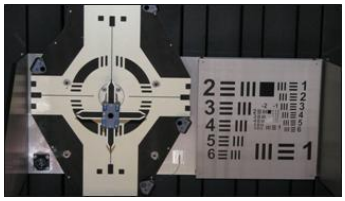
February 2010

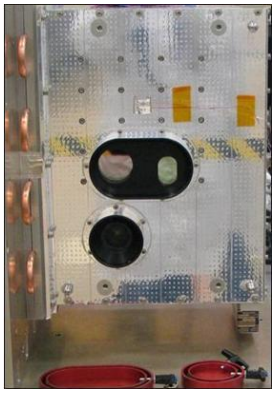
- **Ground Test Article work continues at the Michoud Assembly Facility in New Orleans, Louisiana with the fit check of the forward bulkhead/tunnel in the holding tool (shown below left.)** Once complete, the welding process will begin on the bulkhead/tunnel. The primer prep work began on the barrel (shown below right) and the aft bulkhead is ready for the crush core installation (indicated by the lines on the aft bulkhead.)


- **The inner facesheet layup of the Ground Test Article (GTA) composite heatshield (shown below) was completed at the Lockheed Martin Composite Shop Waterton Facility in Denver, Colorado.** The new cutting edge high temperature resin system was successfully utilized by manufacturing. The heatshield will have a series of machining operations and bonding processes before completion in May 2010. It will then be integrated into the Crew Module GTA vehicle at the Michoud Assembly Facility in New Orleans, Louisiana.

- **The Ground Test Article cone assembly was moved in preparation for final trimming at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** The move is accomplished using the overhead crane, and the personnel seen holding the tag lines (ropes), are there to ensure safe operations.

- **The Sensor Test for Orion RelNav Risk Mitigation (STORRM) Team is completing the ground testing in preparation for actual data collection in a space environment.** The STS-131 mission will include the installation of the reflective elements to the Docking Target (shown below left) on the Space Station during its mission in March. The actual Detailed Test Objective (DTO shown below right) will be flown on STS-134 in late July, where the crew will perform several tasks using STORRM to collect sensor data. The data will be analyzed after the flight, which will improve sensor development to be used on manned and unmanned vehicles.



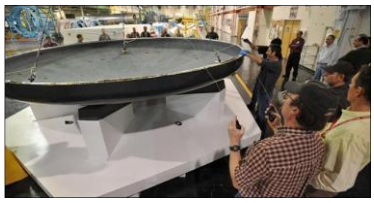
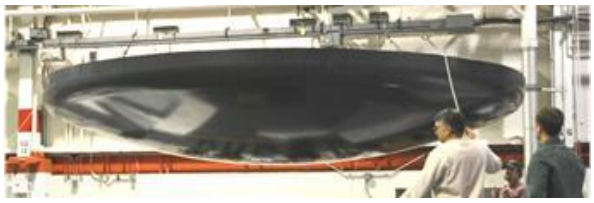


- **The Attitude Control Motor (ACM) arrived at White Sands Missile Range in New Mexico (shown below) in preparation for Pad Abort 1.** With the arrival of the ACM, all of the major components of the Launch Abort System are on site ready for final integration.



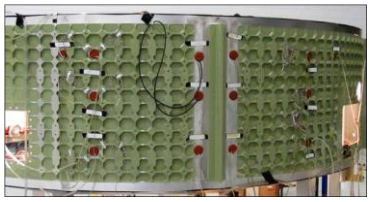
- **Construction progress continues on the Reverberant Acoustic Test Facility (RATF) at the Plum Brook Facility in Sandusky, Ohio.** The third 15–foot wall pour brings the height of the RATF walls to about 45 feet from the finished floor. When the project is complete, the RATF, will simulate spacecraft launch and ascent acoustic environments, accommodating high power acoustic testing of large space vehicles. It will be one of the largest and most powerful in the world, reaching an overall sound pressure level of the 163dB in the empty chamber.

- **The Orion thermal protection system team achieved a major technology milestone by completing fabrication of the world's largest heat shield structure.** The five meter shield (shown below) was pulled from its layup mold at Lockheed Martin's composite development facility in Denver, Colo. The shield was fabricated with a cutting edge high-temperature composite material system developed by Lockheed Martin in partnership with Tencate Advanced Composites, a leading supplier of aerospace thermoset and thermoplastic prepregs. TenCate's composite materials are used in commercial aircraft, radomes, satellites, general aviation, oil & gas, medical and high-end industrial applications.

- **Integration of the Attitude Control Motor (ACM) to the Launch Abort System (LAS shown below) has begun at White Sands Missile Range (WSMR) in support of Pad Abort-1 (PA-1).** Once the hardware integration is complete, the WSMR team will focus on the Soft Mate tests which will test the integration of the electronics for the entire PA-1 Launch Abort System.

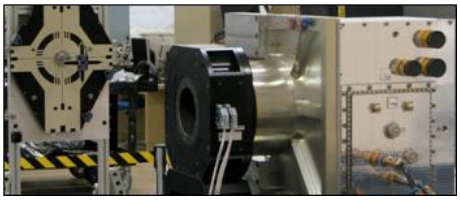
- **Strain Gauge installation activity on the barrel segment (shown below) of the Ground Test Article has been completed at the Michoud Assembly Facility in New Orleans, Louisiana.** A total of 70 gauges have been installed on the barrel article, which will be used in support of the proof testing later this year. The barrel will next move to the welding tool where it will be mated with the cone article.

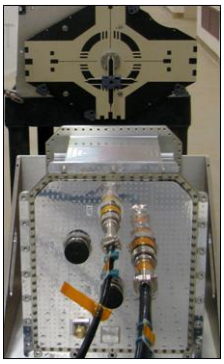


March 2010

- **Significant progress continues on the overall integration of the Launch Abort System (shown below) for Pad Abort 1.** The electrical system is now fully integrated and the raceway cover installation has begun. In addition, successful softmate testing was conducted this week, finishing two days ahead of schedule. The team is in the beginning stages of Phase testing and will begin the countdown/countup testing next week.

- **The Sensor Test for Orion RelNav Risk Mitigation (STORRM) Team continues ground testing prior to delivery to Kennedy Space Center for launch on STS-134.** The ground testing successfully demonstrated that the Vision Navigation Sensor (VNS) can operate from 5.5 kilometers to just under 2 meters. Testing of the DTO augmented target (shown below with blue elements mounted to the ISS visual target along with the STORRM Sensor Enclosure Assembly (SEA) was performed at 2 meters in Ball Aerospace's clean-room. Additional testing was performed (shown below right) with a target to sensor separation of 41 inches (1.04 meters), clearly meeting the 2.0 meter requirement.

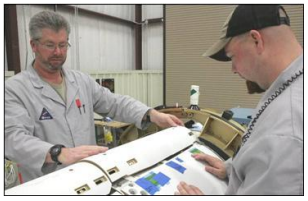




- **A test of the NASA Crew Exploration Vehicle (CEV) in the Launch Abort System (LAS) configuration was carried out in the Boeing Polysonic Wind Tunnel facility in St. Louis, Missouri.** The primary objective of this test (shown below) was to provide some quick look aerodynamic force and moment data on the LAS for comparison and validation with computational fluid dynamics (CFD) simulations. A secondary objective was to provide some limited AOA (Angle of Attack) data for the Alternate Launch Abort System.

- **The Pad Abort 1 Launch Abort System (LAS shown below) is nearly fully assembled for flight.** Final integrated checks with the Crew Module (CM) were conducted successfully, verifying full functionality and data systems are all working properly. All system checks were successful and completed ahead of schedule. The motor joints (shown below right) have been closed out for flight as well. The nose cone will be installed the weekend of March 13, in preparation for rollout on March 29.





- **A major milestone was met as the first two major components of the Ground Test Article (GTA) were welded together at the Michoud Assembly Facility in New Orleans, Louisiana.** The Aft Bulkhead and Barrel were welded together (shown below) using the Self Reacting Weld process (shown below right.) Next, the Cone Assembly will be welded to the Mid Ring, and the Backbone assembly will be installed into the barrel/aft assembly.


- **Alliant Techsystems (ATK) successfully completed the second of two ground tests of a full-scale attitude control motor (ACM) for the launch abort system (LAS) at their facility in Elkton, MD (shown below.)** The test evaluated environment extremes and ignition system robustness in addition to confirming the motor performance. This test of the control motor validates the readiness for the upcoming pad abort 1 (PA-1) flight test that will be conducted at White Sands Missile Range (WSMR), New Mexico.


- **Progress continues at the White Sands Missile Range (WSMR) in preparation for Pad Abort 1 (PA-1.)** Several milestones were reached this week including the nose cone to attitude control motor mate (shown below left) as well as several Crew Module (CM) closeouts. The scaffolding surrounding the CM was removed (shown below right) and only a few closeouts remain before the CM is ready to be moved into position for PA-1.


- **The Pad Abort 1 flight test crew module was moved in position on the launch pad for the stacking of Launch Abort System (LAS) early next week.** The upcoming flight test will demonstrate the capability of the LAS to propel the module to a safe distance from the launch vehicle and the performance of the abort, jettison and attitude control motors. Valuable data from the test will have wide applicability to future launch vehicles.




- **Progress continues at the Michoud Assembly Facility in New Orleans, Louisiana on the Ground Test Article (GTA.)** Shown below is the cone section of the GTA in place to begin the trimming process. Once trimming is complete the cone will then be ready for welding to the mid ring.

April 2010

- **The Launch Abort System (LAS) (below, middle) is ready to stack atop the crew module on the pad for the upcoming Pad Abort 1 test at White Sands Missile Range (WSMR) in New Mexico.** Recent high winds of over 70 miles per hour have prevented installation, but the team should get a window of opportunity in the next few days, keeping them on track for a May 6 launch. Other milestones were achieved recently at WSMR with the government acceptance of the Launch Abort System (shown below left) and the installation of all of the lightning towers (below middle) on the pad.




- **Ground Test Article (GTA) work continues at the Michoud Assembly Facility in New Orleans, Louisiana.** The team is ready to begin the installation of the backbone assembly to the Crew Module (CM) Barrel/Aft Assembly using the CM backbone assembly fixture shown below.

- **The Sensor Test for Orion RelNav Risk Mitigation (STORRM) team recently met with the crew of STS-134 (shown below) to train on how to use the STORRM equipment to collect data during their upcoming mission.** The training involved the sun simulator being placed at differing angles around the docking ring providing glint, glare and shadows. Then the centerline camera was translated toward the docking ring to simulate an approach. The STORRM reflective elements were not distracting to the crew.

- **An exciting milestone was reached at White Sands Missile Range (WSMR) as the Launch Abort System (LAS) was mated with the Crew Module (CM) on the test pad in preparation for the upcoming Pad Abort 1 flight test.** All of the hardware is in place for the May 6 test. The PA-1 team will spend the next few weeks performing systems tests (including a mission rehearsal) and will close out all pad and vehicle operations.





- **The Sensor Test for Orion RelNav Risk Mitigation (STORRM) Reflective Elements (shown in kit below right) are set for installation this week by ISS crew member Soichi Noguchi shortly after STS-131 docks to ISS.** STORRM team member Byron Meadows was on hand at Kennedy Space Center and briefed the STORRM DTO at a launch reception attended by individuals from private industry, NASA centers and Charlie Bolden, NASA Administrator (shown below right.)


- **The Launch Abort System (LAS) thermal protective cover fit check (shown below) was performed recently at White Sands Missile Range in support of Pad Abort 1.** The thermal cover is used to control the temperature of the motors prior to launch.

- **Preparation continues for the upcoming Pad Abort 1 flight test in early May.** The team performed a stack alignment laser shoot (shown below middle,) conducted a successful flight test article post stack functional test, installed the Launch Abort System thermal protective cover (shown below left) to begin obtaining data for thermal launch constraints and installed and mated the main vehicle batteries (shown below right) to the avionics hardware.



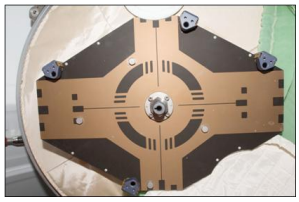
- **Work continues on the Ground Test Article (GTA) at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** The trimming process began this week on the confidence panels (shown below). These panels provide a representative geometry to validate the weld schedule & procedures, prior to welding the GTA Cone and Mid Ring assembly. Shown above is the positioning of the slings to load the clamp used to hold the confidence panels in place during trim operations.


- **The Pad Abort 1 team continued preparing for the upcoming test with a full mission rehearsal (shown below) at White Sands Missile Range (WSMR) in New Mexico.** The rehearsal was an exact run through of all of the components that will be involved during the actual test from communication to the range to the chase helicopters locating the test article after it lands. Everything went as planned during the rehearsal.

- **The Ground Test Article (GTA) took another step towards becoming a completely assembled crew module as fittings were installed to the backbone (shown below) at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** Once all of the fittings are mounted to the backbone, the entire backbone assembly will be ready to be integrated with the aft bulkhead and barrel GTA, which have already been welded together (also shown in picture.) The MAF team has also completed the cone/mid ring confidence panel welds, has begun the Non Destructive Evaluation (NDE) of the welds, and is now preparing for the cone to mid ring weld on the GTA.

- **The Sensor Test for Orion RelNav Risk Mitigation (STORRM) Reflective Elements were installed on the PMA-2 visual docking target by ISS crew member Soichi Noguchi (shown below) during the recent STS-131 docked operations.** The reflective elements (the four gray, triangle objects on target below) comprise the short-range docking target for the Vision Navigation Sensor (VNS). The reflective elements will reflect light at wavelengths greater than 1200 nano-meters (the VNS operates at 1570 nm). The returns from the reflective elements will be seen as “bright” spots by the VNS and will be used to determine the relative position and relative attitude of the docking target with respect to the sensor.

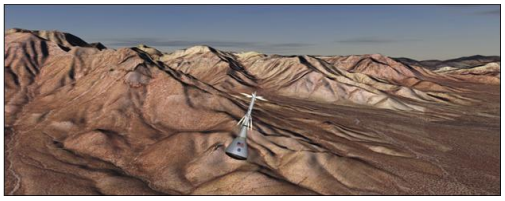
  This information will use the Relative Navigation filter to further refine the relative states between the chaser and target vehicle in support of rendezvous and docking. With the aid of the reflective elements, the VNS would require orders of magnitude more processing capabilities to operate with specific features (similar to feature recognition algorithms in development today).



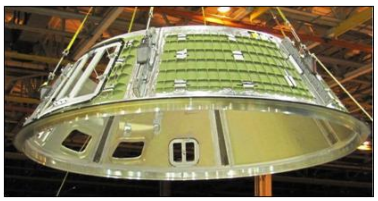
- **With less than one week to launch, the Pad Abort 1 team continued preparations for the upcoming test on May 6th at White Sands Missile Range (WSMR) in New Mexico.** The team continues to meet all major milestone requirements as the final closeout of the launch vehicle nears.

- **NASA and engineering support contractors completed a demonstration test of the main parachute test equipment (shown below) for the Orion crew exploration vehicle at the U.S Army's Yuma Proving Grounds in Yuma, Ariz.** The demonstration is part of a series of tests to support the design and development of the Orion parachute recovery system, which is derived from the system NASA used to recover the Apollo spacecraft.

- **The Orion System Management (SM) team provided a demo (shown below) to the Standing Review Board (SRB) in Kedalion that featured several Orion Flight Test Article flight scenarios.** The Kedalion test bed includes a Honeywell VMC Test Bench, Osiris/Antares sims, TTGbE bus, sensor stimulators (GPS simulator, starfield generator, rate table), and ground control equipment (EGSE) operating in a closed-loop enabling significant engineering analysis and concept validation. The demo content was partially enabled by close collaboration of the NASA SM team with Lockheed Martin, using an Integrated Synch Point (ISP) strategy for incremental prototype and/or flight software development.



- **Welding progress continued on the Ground Test Article (GTA) at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** Recently the team completed the cone/mid ring weld (shown below) and was labeled “100% clean” through the Non Destructive Evaluation (NDE). Next, the team will work on trimming the upper surface of the cone while work continues on the backbone assembly.



May 2010

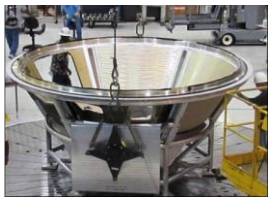
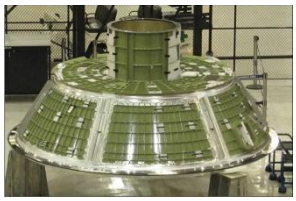
- **After years of hard work, dedication, professional excellence and personal sacrifices, the Pad Abort 1 team executed a fully successful test at White Sands Missile Range (WSMR).** With the success of the test, The NASA and commercial industry team overcame the last of many obstacles in demonstrating the new launch abort technology that is the next step in human rating the Constellation Orion crew exploration vehicle that will ensure the safety of our astronauts during future exploration missions. The test demonstrated the integrated operation of three newly developed rocket motors each of which represent unique contributions to the state of the art in solid rocket propulsion. All initial data indicate that everything from the motors to the parachutes performed to expectation or better. The team will recover all test assets for inspection and collect the flight data over the next 24 hours for detailed performance evaluation to be conducted over the next 90 days.

- **Shown is the Launch Abort Vehicle at launch (below right) and the flight test article crew module just after the main parachutes deployed (below left).**

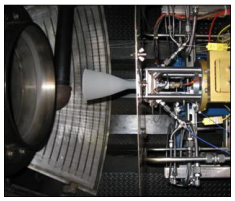
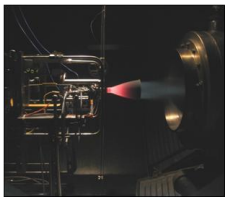
- **Data continues to flow in from last week's Pad Abort 1 Test at White Sands Missile Range (WSMR) in New Mexico.** All of the hardware has been recovered and the team has begun disassembling and inspecting the various components. Data continues to indicate that there were no system anomalies, which validate the design of the Launch Abort System (LAS) and help continue the development path to CDR.

- **The trimming process continued on the Ground Test Article (GTA) at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** The Cone section of the GTA (shown below right) was trimmed in preparation for the upcoming weld to the Forward Bulkhead (shown in foreground below left.) The Forward Bulkhead was placed onto the Cone section after trimming for a fit check to make sure everything is lining up properly before welding takes place. The two sections are scheduled to be welded together in the upcoming week.


- **The welding of the Ground Test Article (GTA) Cone to Forward Bulkhead (shown below) was completed at the Michoud Assembly Facility in New Orleans, Louisiana.** The cone/forward bulkhead assembly was then moved into position and will be mated with the barrel assembly in preparation for the closeout weld which is scheduled to be complete by the end of the month.

- **Aerojet successfully completed a second set of hot-fire test sequences of its R-1E 25-pound thrust, bipropellant engine.** This second test included more than 17,250 seconds of total burn time, demonstrating engine flexibility to operate under a broad variety of conditions expected for NASA's Orion service module. Initial test results indicate the engine performed successfully in simulated space-flight mission scenarios.

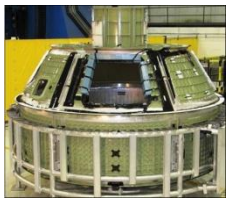



- **The closeout weld of the Crew Module (CM) Ground Test Article (GTA shown below) was completed at the Michoud Assembly Facility in New Orleans, Louisiana.** The cone/forward bulkhead assembly was placed upside down onto the turntable then the barrel assembly was placed on top (shown right) in preparation for the closeout weld. Next, the GTA team will conduct Non Destructive Evaluation (NDE) inspections and begin the next sequence of mechanical assembly work in preparation for the upcoming proof testing.



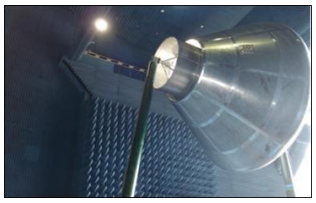
June 2010

- **Work continues on the Crew Module (CM) Ground Test Article (GTA) at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** Following the successful completion of the closeout weld, the MAF team has continued to prepare the GTA for the upcoming proof pressure test. At the current time, the CM (shown below) has been moved from the weld area and the team is now performing mechanical assembly work that is required to put the CM into a proper configuration for the proof test later this month.



- **United Space Alliance (USA) has completed the installation of heatshield tiles to Panels C & E of the Ground Test Article (GTA.)** Panels C&E have representative AETB-8 tiles manufactured and installed by USA. These panels are manufacturing demonstrations that allow the team to work through CAD data transfers, structural surface preparation and installation procedures. Gap filling (being performed in picture below) fills the space between tiles to minimize aerothermal heating when gas flow enters the gaps. The panels will now be processed to be shipped to the Michoud Assembly Facility (MAF) for installation.

- **A prototype of the Ball Aerospace phased array antenna mounted on a full scale Crew Module/Service Module (CM/SM) Mockup was recently tested in the JSC Anechoic Chamber.** This testing will be used to validate the RF models that are critical to the design of the Orion S-band communications system.



- **The Orion Main Engine development level combustion injector (shown below) has been installed on the test stand at Aerojet Sacramento.** This hardware will be used in a series of hot-fire tests that will demonstrate the performance of the injector and includes unique tests to evaluate combustion stability as a pre-declared qualification. Testing will be conducted in June and July.

- **Fabrication of the Crew Module (CM) Reaction Control System (RCS) thruster has begun.** The high fidelity mass simulators (shown below) from Aerojet Redmond will be integrated into a pod housing which will then be integrated into the Crew Module Ground Test Article. This hardware provides for demonstration of the installation of the engines with the CM pressure vessel and the outer moldline.

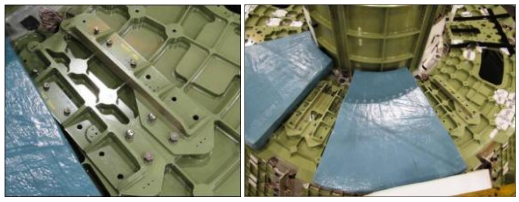
- **Brantley Adams, Vice President and General Manager of Jacobs Inc, Rome Group; Larry Price, Deputy Manager of the Orion Project - Lockheed Martin; Mayor Molly Ward of Hampton, Va.; Congressman Bobby Scott - 3rd District of Virginia; Mark Kirasich, Orion Deputy Manager; and Steve Jurczyk, Deputy Director of NASA's Langley Research Center participated in the Hydro Impact Basin Groundbreaking Ceremony (shown left) at NASA Langley on June 8th.** The Hydro Impact Basin will measure 115 feet long, 90 feet wide and 20 feet deep. Once complete, researchers will conduct water impact tests that will ensure that future space vehicles are designed properly for safe water landings.

- **The recently constructed Medium Fidelity Mockup (shown in foreground below) took its place in Building 9 at Johnson Space Center next to the Low Fidelity Mockup (shown in background.)** Construction on the mockup will continue over the next two months with the installation of exterior panels and other essential hardware components. The Medium Fidelity Mockup will serve as an updated model for evaluating hardware design and operational concepts with the astronaut crew and engineers.

- **The boilerplate crew module that was the focus of the recent Orion Launch Abort System Pad Abort-1 flight test at the U.S. Army's White Sands Missile Range in New Mexico on May 6 has been returned to NASA's Dryden Flight Research Center.** The crew module and its separation ring (shown below) were airlifted back to NASA Dryden at Edwards Air Force Base on June 15 from Holloman Air Force Base aboard a Mississippi Air National Guard C-17. The success of the PA-1 launch has opened an opportunity to re-fly the PA-1 crew module on another launch abort test flight in 2012, which will save time in the schedule and significantly lower costs.

- **Mechanical assembly work that is required for the upcoming proof pressure testing continues on the Crew Module Ground Test Article (GTA) at the Michoud Assembly Facility in New Orleans, LA.** Prep work has begun on the Forward Bay area (shown below) for the installation of the gussets as well as the retention and release brackets. In addition, the final connections have been made of the backbone assembly to the Crew Module barrel assembly longeron. Prep work will continue over the next few weeks before the GTA is moved from its current location to the proof pressure test area.

- **Progress continues on the Crew Module (CM) Ground Test Article (GTA) at the Michoud Assembly Facility in New Orleans, Louisiana.** The team recently completed the Backbone fastener and shear pin installation as well as the Forward Gusset Bracket installations (shown below.) In addition, the installation of the wire harnesses continue, which is required for the upcoming proof pressure tests. Next, the team will install the Forward Gussets into the brackets and continue the wire harness installation work.

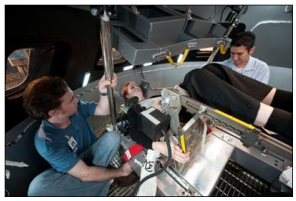


- **The first firing of the Orion Docking Mechanism Jettison System (DMJS) source shock characterization test (shown above before and during test) was conducted successfully on June 10, 2010 at Lockheed Martin's Engineering Propulsion Laboratory (EPL) located in Littleton, Colorado.** Separation of a Low Impact Docking System (LIDS) mass simulator was accomplished with a single Linear Shaped Charge (LSC) explosive wrapped around a thin-walled cylindrical aluminum tube representing the CEV Crew Module (CM) Tunnel. The tube was welded to a medium fidelity CM Forward Bay simulator in order to approximate the stiffness of the spacecraft. The primary test objective of gathering clean pyroshock data for analysis was accomplished and several secondary test objectives designed to study the hazards associated with the pyrotechnic separation event were also included. Two additional test firings are planned in order to study the statistical scatter in the test results and allow better quantification of the Maximum Predicted Environment (MPE) of the docking jettison event, which occurs just after the de-orbit burn initiating atmospheric re-entry of the CEV on return from the International Space Station (ISS).

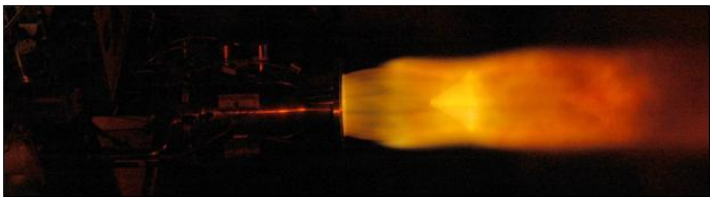
July 2010

- **Gusset fit checks were performed this week (shown below) on the Orion Crew Module Ground Test Article (GTA) at the Michoud Assembly Facility in New Orleans, Louisiana.** The team will now begin the actual permanent installation of the gussets to the GTA.

- **NASA and Lockheed Martin engineers evaluate the latest Orion space craft crew seat assembly installed in the full size Orion Human Engineering Structural Mockup (HESM).** The engineers installed the seat in the mockup, evaluated the operation of the mechanical features of the seat and evaluated installation options for flight controls onto the seat. The HESM is located in the Lockheed Martin Engineering Development Laboratory in Houston, Texas.

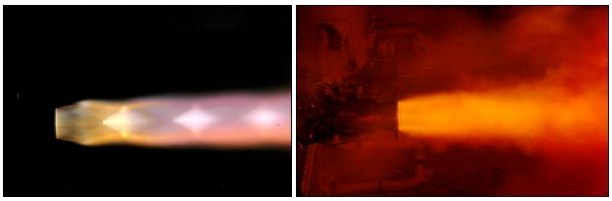
- **Checkout testing of the Orion Main Engine (OME) Development #1 injector (shown below) continued at Aerojet-Sacramento.** The tests are initial test validation of the revised manufacturing techniques being employed on the OME injector. The first three tests were conducted with the heat sink test assembly at the nominal OME design point. Testing resumed using the pulse gun test assembly at the nominal OME design point resulting in good performance and the injector face in good condition after the test. Further checkout testing with the pulse gun test assembly is planned for this week.



- **The installation of the forward bay gussets on the Crew Module (CM) Ground Test Article (GTA) is nearing completion at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** In addition, the MAF team has continued the permanent installation of wire harnesses and has begun installation of the window and closeout panels that are required for the upcoming proof tests.

- **The 26-AA wind tunnel test program in the Unitary Plan Wind Tunnel at the Ames Research Center continues to obtain aerodynamic and air loads data.** The testing shows how the Launch Abort Vehicle flies under various flight conditions, especially as it travels from subsonic speeds through transonic and supersonic speeds into the critical area of maximum dynamic pressure where the vehicle feels the strongest aerodynamic forces and moments. The testing provides critical data on how the plumes from the abort motor (shown below right) change depending on the vehicle's speed and ambient pressure, and more importantly the effect of these plumes on the aerodynamics of the vehicle in the event that an abort is needed during ascent. All of these data are essential to human rate a spacecraft and provide crew survival capability in case of ascent abort. The wind tunnel team has completed the subsonic and transonic portions of the tests (Mach 0.3 to 1.3) and will next focus on the supersonic portion of the test (Mach 1.6 to 2.5.) The 26-AA testing is expected to wrap up in early August.

- **Aerojet has completed its Orion Main Engine (OME) Dev. 1 Injector test checkout series (shown below.)** Next up, the Aerojet team will focus on the pre-declared qualification combustion stability test, which is targeted to begin next week.



- **Work on the Crew Module (CM) Ground Test Article (GTA) continues at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** In parallel with the Forward Bay Gusset installation that has been taking place, the MAF team is installing test covers for the CM windows and hatch opening (shown above.) The covers include a gasket, which provide a tight seal that is needed during the upcoming CM pressure testing.

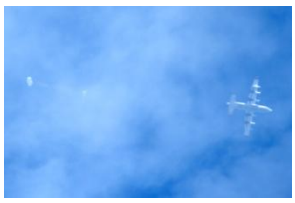
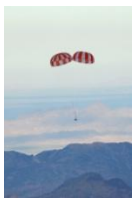
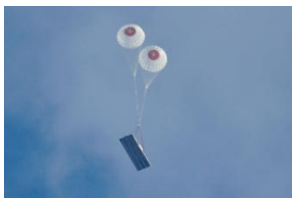
- **Progress continues on the Orion Crew Module (CM) Ground Test Article (GTA) at the Michoud Assembly Facility in New Orleans, Louisiana.** The CM GTA was recently moved out of the tooling that was used to complete the forward bay gusset installation, onto the dolly/tooling where instrumentation and more mechanical assembly work will continue. The team will now work on installing six “legs” to the barrel part of the CM GTA, which will hold the CM GTA in place during the upcoming proof pressure test. This initial Orion spacecraft will be used for a series of ground and flight tests.

- **Lockheed Martin's John Ringelberg briefed NASA management (bottom right) during a familiarization tour of Lockheed's Space Operations Simulation Center (SOSC) in Denver, CO.** Shown below left is Constellation Program Manager Dale Thomas performing a simulated Orion ISS approach and docking maneuver in the Space Cockpit Operations Development Tool (SCODT) located at the SOSC. The SOSC – a Lockheed Martin funded high-tech facility – provides an ultra-stable test environment for precision instruments and accurate navigation systems used in space vehicles. It supports Orion by reducing program risk through verifying autonomous rendezvous and docking capabilities for the International Space Station, as well as alternate mission capabilities involving asteroids and other space-based systems. The development, evaluation and testing of these elements are necessary requirements for ensuring safety and the success of human and robotic missions to earth-orbiting platforms, planets, moons and other bodies in our solar system.


- **STS-134 crew members (shown below) get a briefing on the STORRM DTO (Sensor Test for Orion Relative Navigation Risk Mitigation Development Test Objective) by lead project engineer, Heather Hinkel, at the Ball Aerospace Facility in Boulder, Colorado.** This docking navigation system prototype was developed collaboratively by NASA, Ball and Lockheed Martin and will be tested by astronauts aboard STS-134 in an unprecedented on-orbit maneuver during the space shuttle mission to the ISS in February 2011. On Flight Day 11 of the mission, the shuttle crew will undock from the ISS and then re-rendezvous with the station on an Orion-like approach.


- **A successful parachute airdrop test took place shortly after sunrise on July 27 at the U.S. Army Yuma Proving Grounds in Arizona.** The primary test objectives were 1) to measure the performance of a two drogue parachute cluster with one drogue skipping the second of two reefing stages and 2) to measure the performance of a two main parachute cluster with modified suspension line and riser lengths matching the Apollo configuration ratio. Both primary test objectives were met.

The test platform consisted of a pallet and weight tub and was extracted from a C-130 aircraft at 17,500 ft. The two drogue parachutes and two main parachutes deployed and performed nominally although one main parachute experienced a higher inflation load than expected during reefing stages. The test platform and all parachutes were recovered and returned to the hangar.


- **Work on the Crew Module (CM) Ground Test Article (GTA) continues to progress at the Michoud Assembly Facility in New Orleans, Louisiana.** The outriggers that connect the CM GTA to the dolly for support were installed to move for the upcoming proof testing. Proof testing is a standard part of the production process for a pressure vessel, like the CM primary structure. Proof testing is accomplished by increasing the internal pressure of the module to a level above the normal operating pressure. The structure is measured (strain gauges, pressure readings), and as the pressure is increased, the instrumentation shows the resulting stress/strain on the structure.

August 2010

- **The Sensor Test for Orion RelNav Risk Mitigation (STORRM) hardware left Ball Aerospace & Technologies Corporation in Boulder, Colorado in route to Kennedy Space Center.** On arrival, the STORRM hardware will undergo post-shipping tests before installation into Space Shuttle Endeavour next week. Following installation, tests will verify the STORRM hardware is successfully connected to the Shuttle systems. STORRM hardware is onboard STS-134 and scheduled to launch in February, 2011.

- **The Orion team successfully completed the first test of the Crew Module lifting/lowering structure in the Operations and Checkout Facility at Kennedy Space Center as part of their pathfinder risk reduction operations using a full-scale Orion mockup.** This is the facility's first major tooling station that will be used for on-site manufacturing and assembly of the spacecraft just prior to launch – a first for NASA and human spaceflight technology. The tooling station design improves worker safety by providing crew module support so that work is not conducted under suspended loads. This tooling station is "portable" and will be moved to Orion facilities across the country to support on-site manufacturing, assembly and integration work, which is much less expensive than producing multiple tooling stations.

- **The Orion RelNav Risk Mitigation (STORRM) hardware was installed in the payload bay of the Space Shuttle Endeavour.** Installation began with the Sensor Enclosure Assembly (SEA), a 52-pound box about the size of a microwave oven (shown below). The SEA was mounted in place in front of the shuttle's airlock, alongside the existing Trajectory Control System. The location of the docking camera offers an accurate snapshot of how the system would handle on the Orion capsule, and provide precise visual cues to the crew. Next, the 82-pound Avionics Enclosure Assembly, which provides power distribution, data recording and memory for the camera and navigation system was mounted on the port side of the payload bay. Electrical connections were completed and the functional testing verified the STORRM hardware is ready to fly on STS-134 in February 2011.



- **The Orion Ground Test Article team at the Michoud Assembly Facility has completed assembly and installation of the barrel and tunnel test cover and two forward bulkhead test covers.** Work continues on the harness installation and hatch panel assembly. In preparation for the proof pressure test set-up, the routing of the 28 harnesses and the channelization of the 584 channels required for proof test is complete. Progress continues on the bird cage tool, which is used to install the crew module structure necessary for the subsequent installation of the thermal protection system (below left). The crew module is ready to roll out to pressure testing facility the week of August 16, pending weather conditions (below middle).



- **The Orion Crew Module (CM) Ground Test Article (GTA shown below) recently moved from the fabrication building to the proof pressure test building at the Michoud Assembly Facility (MAF) in New Orleans, Louisiana.** The GTA team will now install the Data Acquisition System (DAS) into the GTA and attach the hatch cover. A dry run of the compatibility of the system and hardware will be conducted prior to the actual proof pressure testing.



- **The first two Orion prototype Transponders and the first Orion prototype Baseband Processor were recently delivered to the Lockheed Martin Newtown, PA, facility for integration testing.** These units were successfully integrated and their modes of operation were configured. The test configuration allowed one Transponder to send its RF signal to the other over a simulated RF path. The received signal was demodulated and the resulting soft-decision symbols were interfaced with the Baseband Processor. Successful decoding and unwrapping of CCSDS protocol layers was performed using three different operating modes. Tests completed included acquisition, tracking, symbol error rate, and decoded frame error rate.

  The prototype units (shown below) are first-of-their-kind, implementing new features and advanced capabilities. The tests have confirmed basic performance and integration goals. With the confidence in the units' performance gained from these tests, they will next be sent to the Electronic Systems Test Laboratory (ESTL) at the Johnson Space Center (JSC) for more comprehensive tests, including those involving other NASA communication system elements.